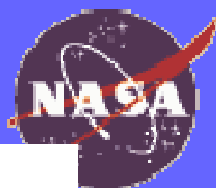


Validating AURA OMI tropospheric SO₂ data with aircraft *in-situ* measurements

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With thanks to all the OMI Science and Support Teams



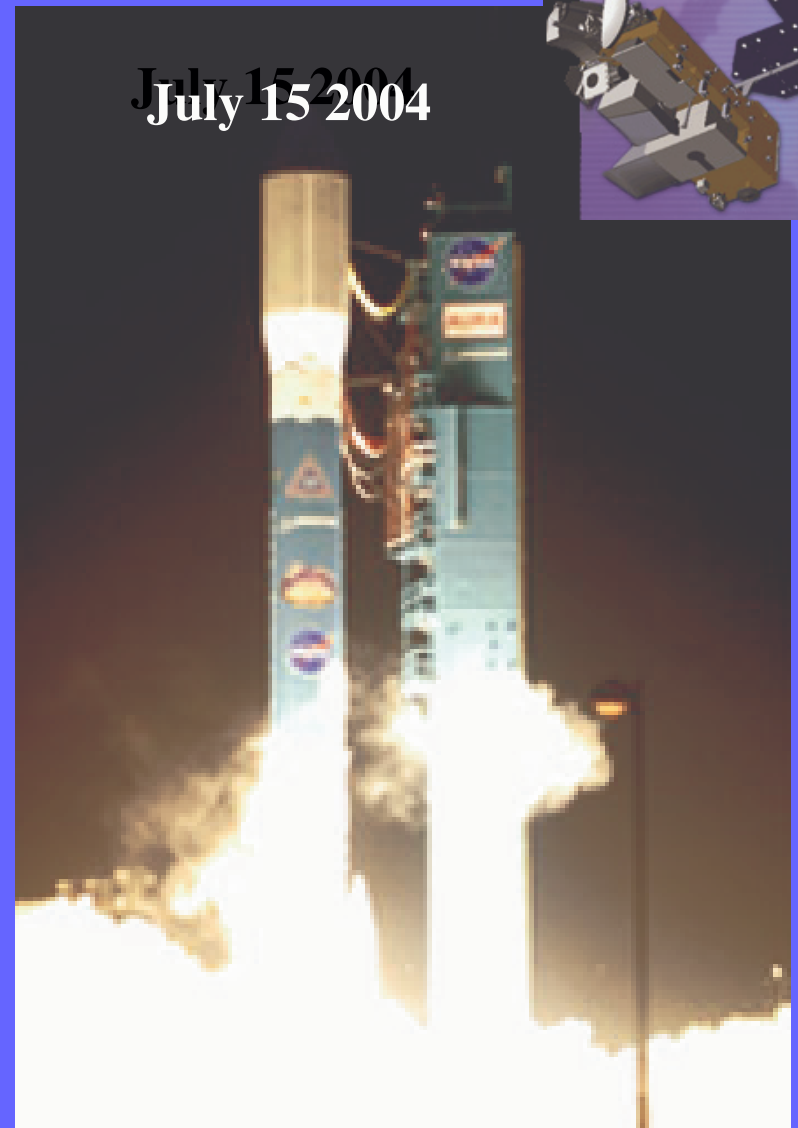
Global Sulfur Sources

	Northern Hemisphere	Southern Hemisphere	Global
Marine and Terrestrial DMS	7.5	11.0	18.5
Volcanic SO₂	10.0	4.0	14.0
Explosive degassing	0.5-4		
Passive degassing	5-10		
Biomass Burning	1.0	1.5	2.5
Fossil Fuel Use and Industry	60.5	6.3	66.8
TOTAL (S, Tg)	79.0	22.8	101.8

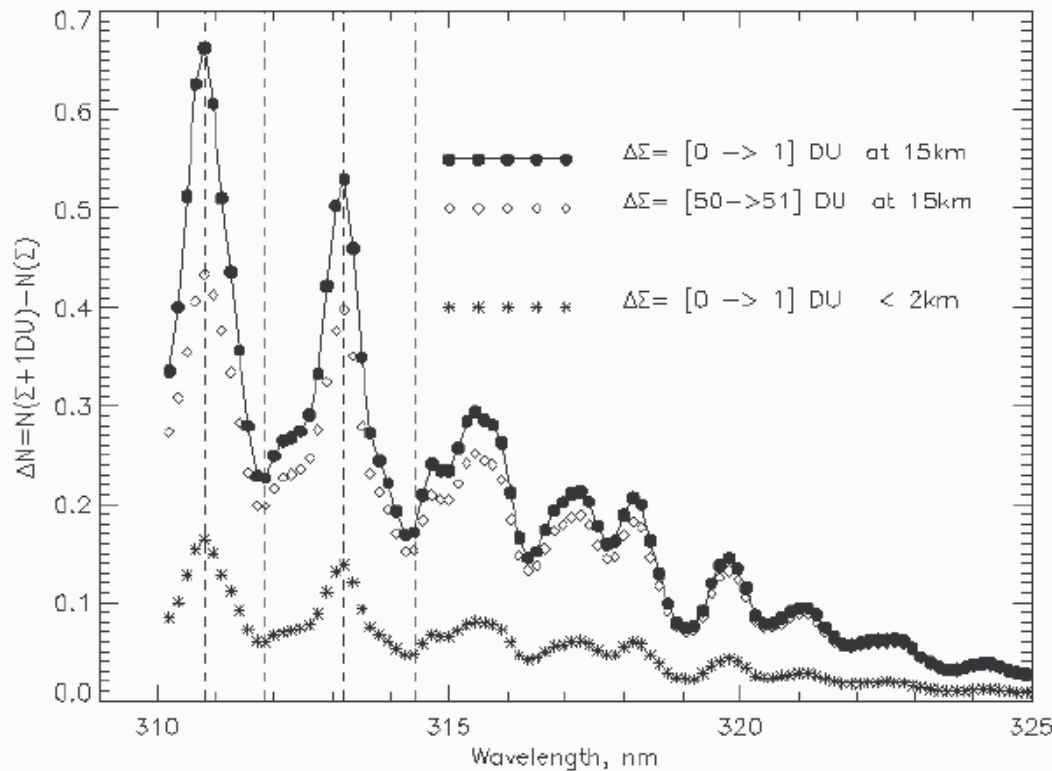
[Bluth *et al.*, 1993; Pyle *et al.*, 1996; Graf *et al.*, 1997; Andres & Kasgnoc, 1998]

Ozone Monitoring Instrument (OMI)

The NASA EOS Aura platform, launched on July 15, 2004, carries the Ozone Monitoring Instrument (OMI), a hyperspectral UV/Visible spectrometer with a 2600 km swath for daily, global contiguous mapping that was provided by the Netherlands's Agency for Aerospace Programs (NIVR) in collaboration with the Finnish Meteorological Institute (FMI) to the EOS Aura mission for continued monitoring of ozone and other trace gases



OMI SO₂ algorithm



An OMI SO₂
Band Residual
Difference (BRD)
algorithm [Krotkov et
al 2005]

uses calibrated
residuals at SO₂
absorption band
centers produced by
the NASA operational
ozone algorithm
(OMTO3)

[Bhartia et al 2002]

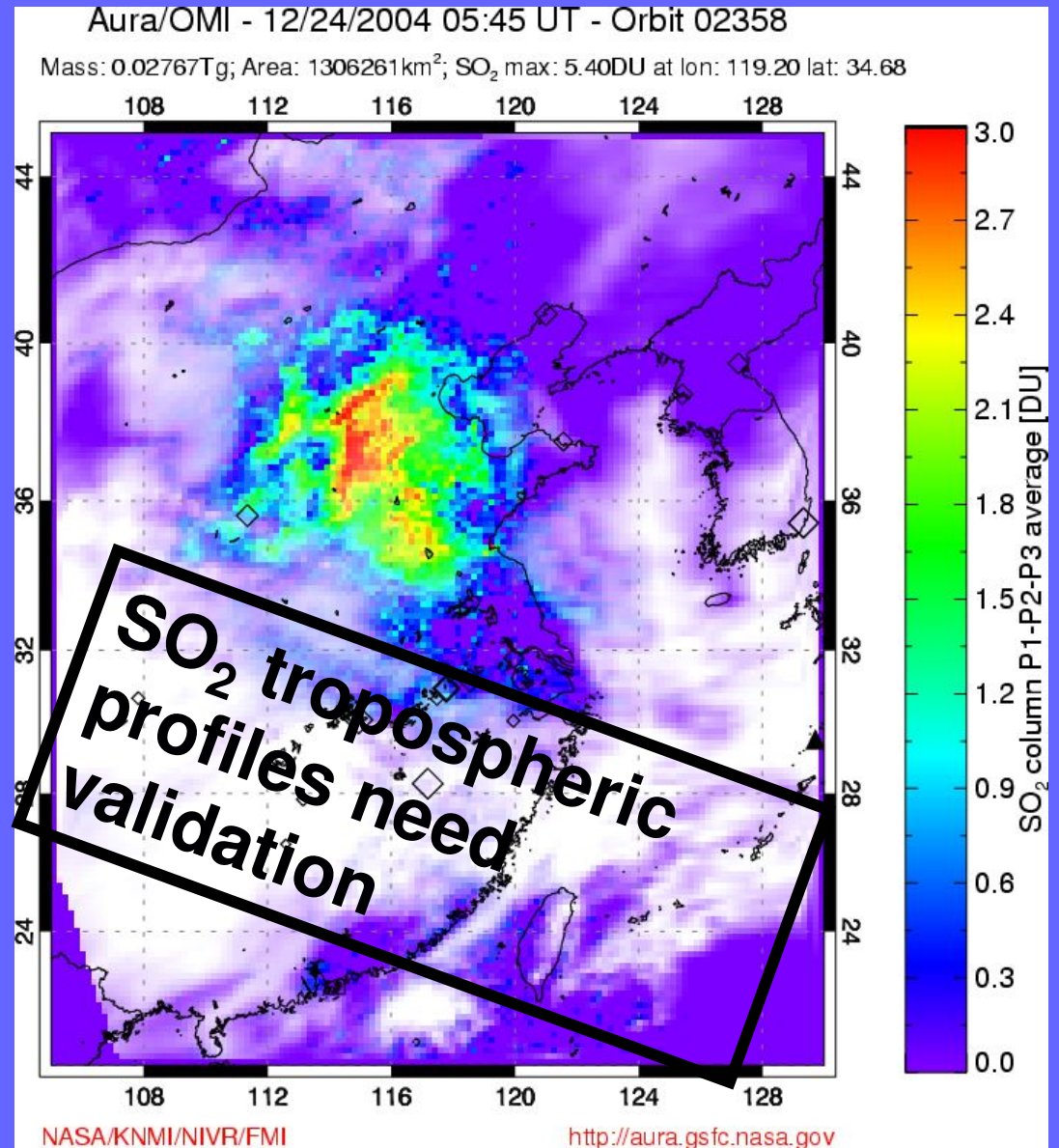
OMI SO₂ provisional products released for validation in July 2005:

1. Explosive Eruptions: 15km
2. Passive degassing: 5km
3. Anthropogenic SO₂ pollution : PBL (<700mb)



SO₂ burdens over China

- 70% of China's energy is derived from coal burning
- SO₂ emissions increased at a rate 35%/decade in 1979-2000.
- China's sulfate aerosol loading has increased by 17%/decade in 1979-2000 [Massie, Torres and Smith 2004]
- 65,000 SO₂ tons/day emitted in 1995 [Streets & Waldhof, 2000]





Aztec-F Aircraft in-situ measurements



GPS Position ($^{\circ}$ Lat, $^{\circ}$ Long)

Meteorology (T, RH, Pr, P_{alt} , WS, WD)

Carbon Monoxide (CO)

Tropospheric Ozone (O_3)

Sulfur Dioxide (SO_2)

Aerosol Optical Properties:

Absorption, b_{ap} (565 nm)

Scattering, b_{scat} (450, 550, 700 nm)

Aerosol Particle Size (MetOne)

6 cuts – Range 0.3-1.0 μm



Pulsed Fluorescence SO₂ detection

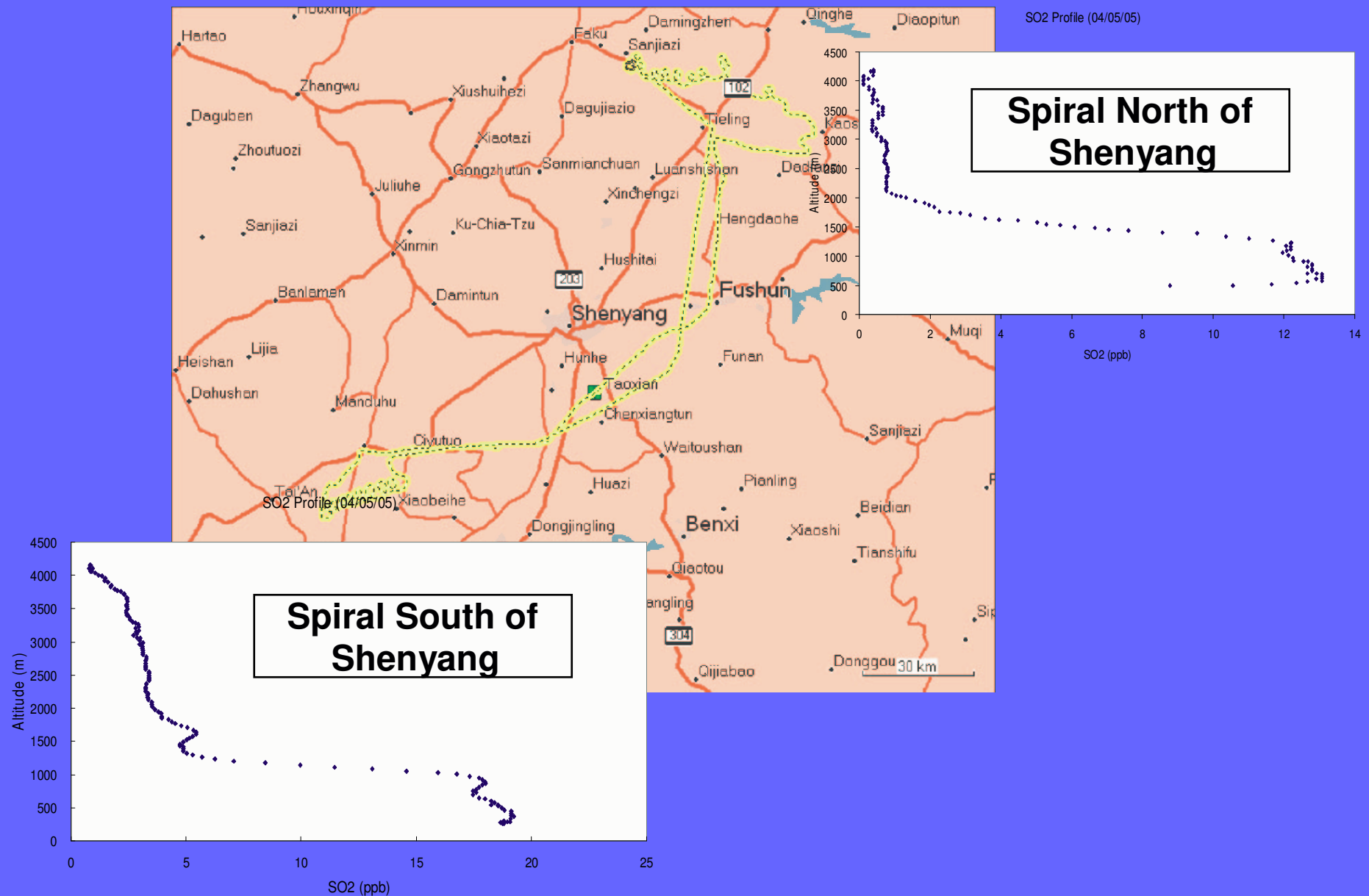
- Pulsed UV source excites molecules
- SO₂ relaxes by emitting visible photon with a specific lifetime
- Potential interferences from hydrocarbons (+) and water vapor (-)
 - Hydrocarbons also fluoresce
 - Water vapor quenches excited SO₂ molecule
- Gated detection:
 - Wait long enough for elastic scattering to stop, but not so long that hydrocarbons start to fluoresce significantly.
 - Makes instrument more specific to SO₂, less sensitive to other fluorescent molecules such as hydrocarbons, which have a much longer fluorescent lifetime.
- Instrument contains a proprietary hydrocarbon “kicker” to reduce hydrocarbon concentration without affecting SO₂.



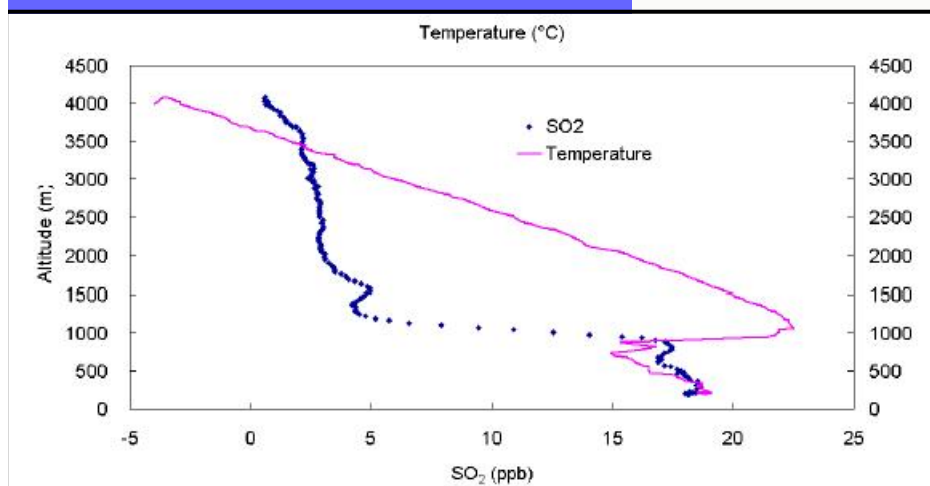
Above: a scientist from UMD (Jeff Stehr) with a Chinese pilot before an airborne experiment in northeast China.



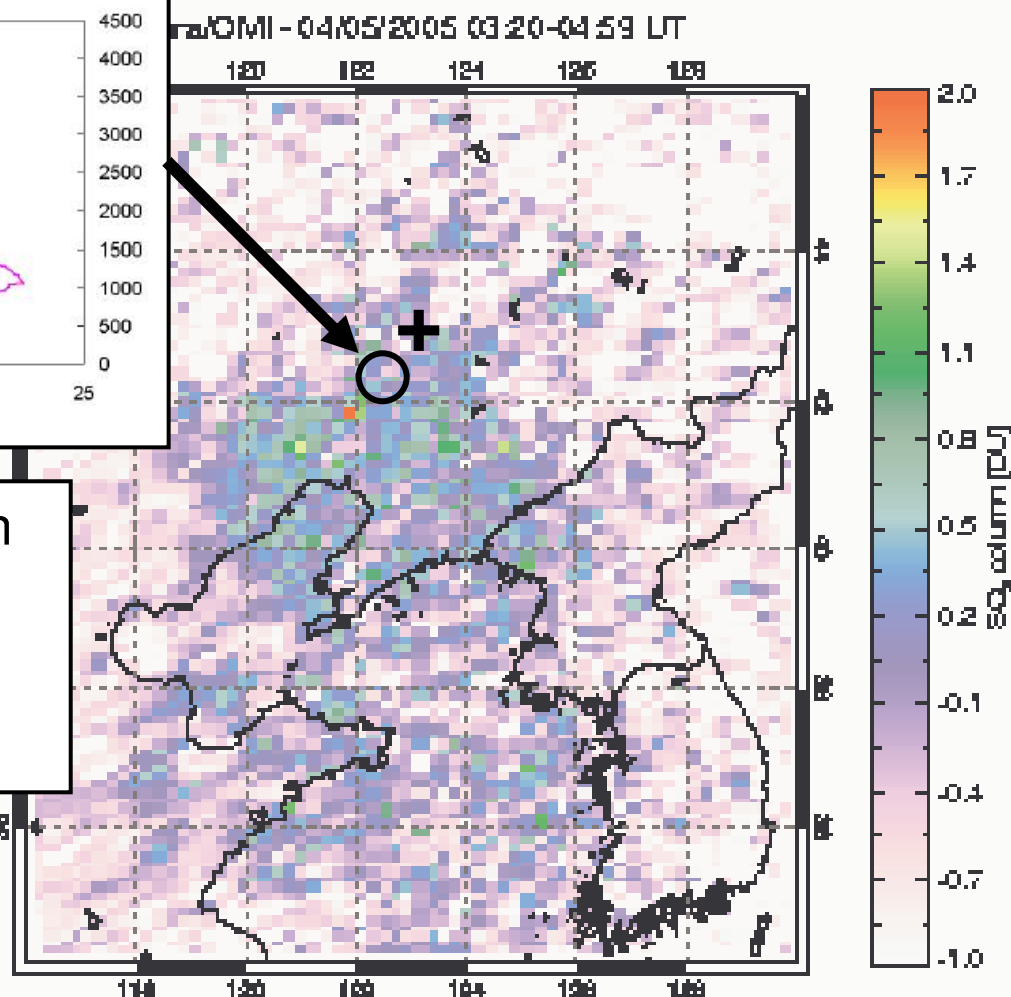
Flights over China in April 2005



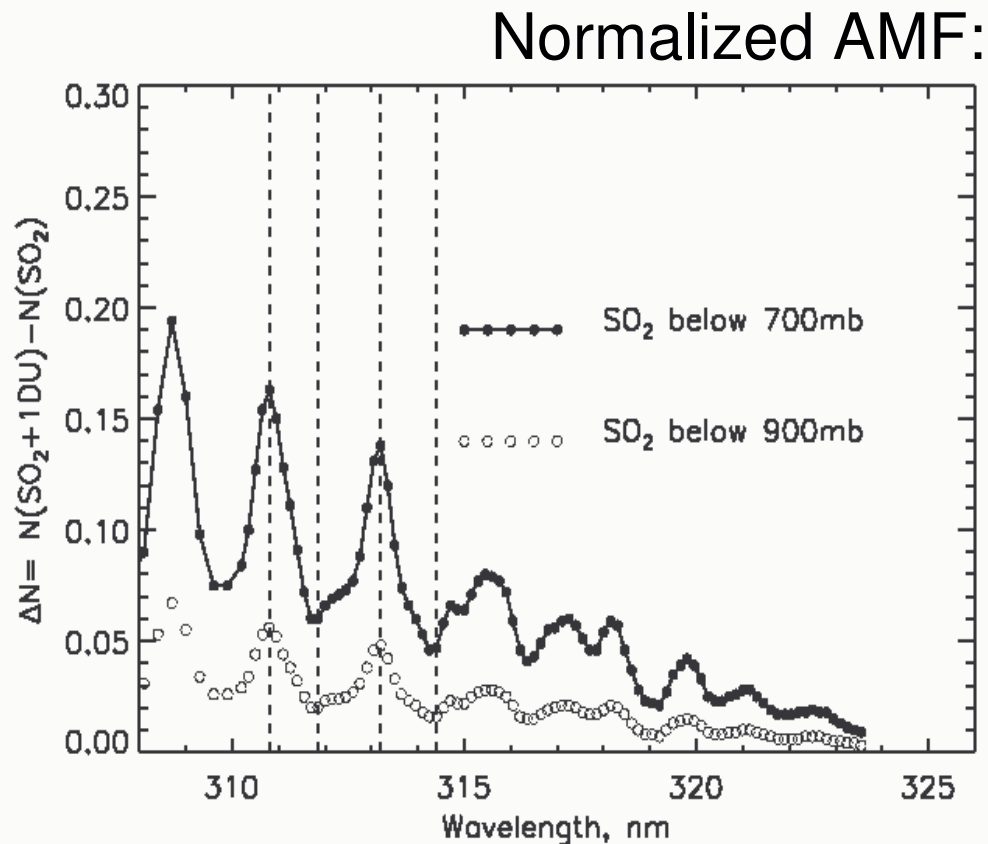
Comparisons South of Shenyang, April 5 2005



In aircraft profile the column content is ~ 2.2 DU with 0.7 DU in the free troposphere.



OMI sensitivity to SO₂ vertical profile



$$g_{p_j} = \frac{10^3}{km_g \gamma_{p_j}} \frac{\Delta N_{p_j}}{\Delta \Sigma}$$

OMI
operational
AMF(700mb)
~0.21

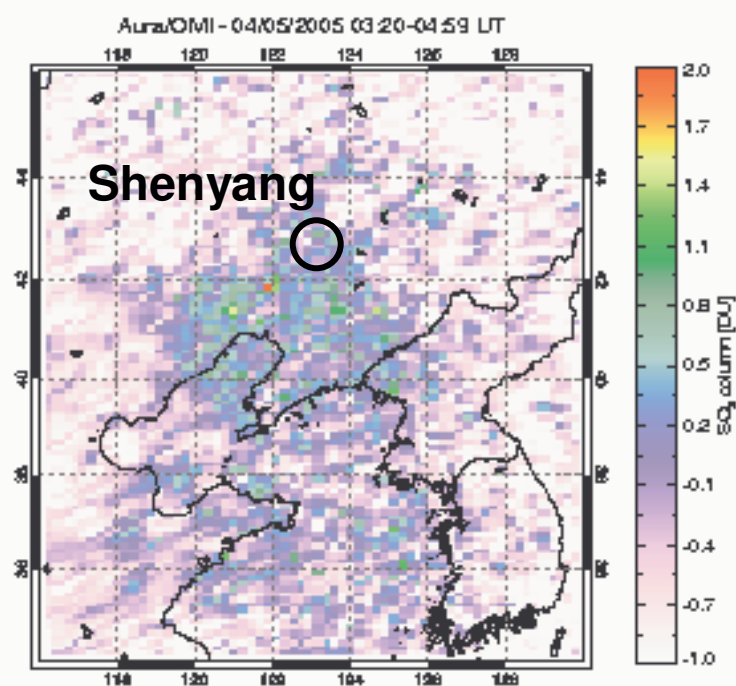
AMF(900mb)
~0.07



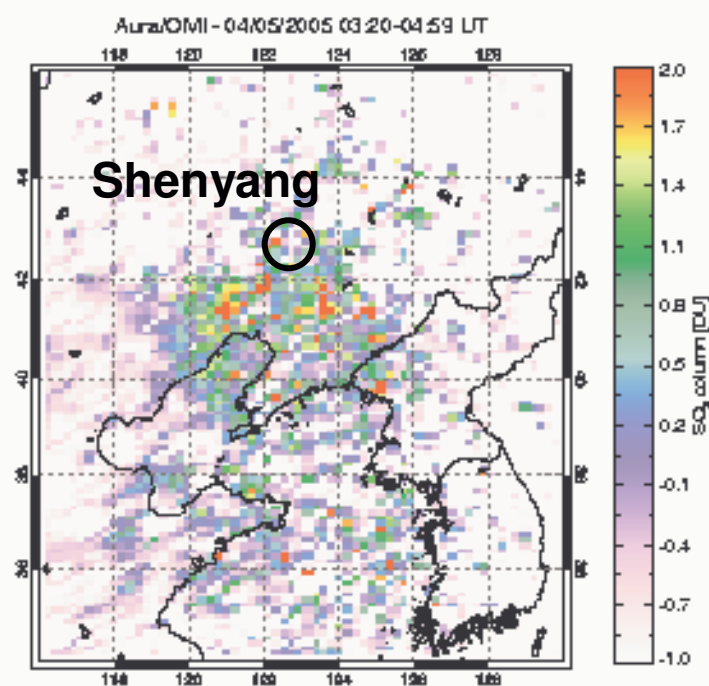
SO₂ (true) ~ 3 SO₂(OMI)

A-priori Profile effect on OMI SO₂ retrieval

SO₂ below 700mb
(OMI Provisional release)



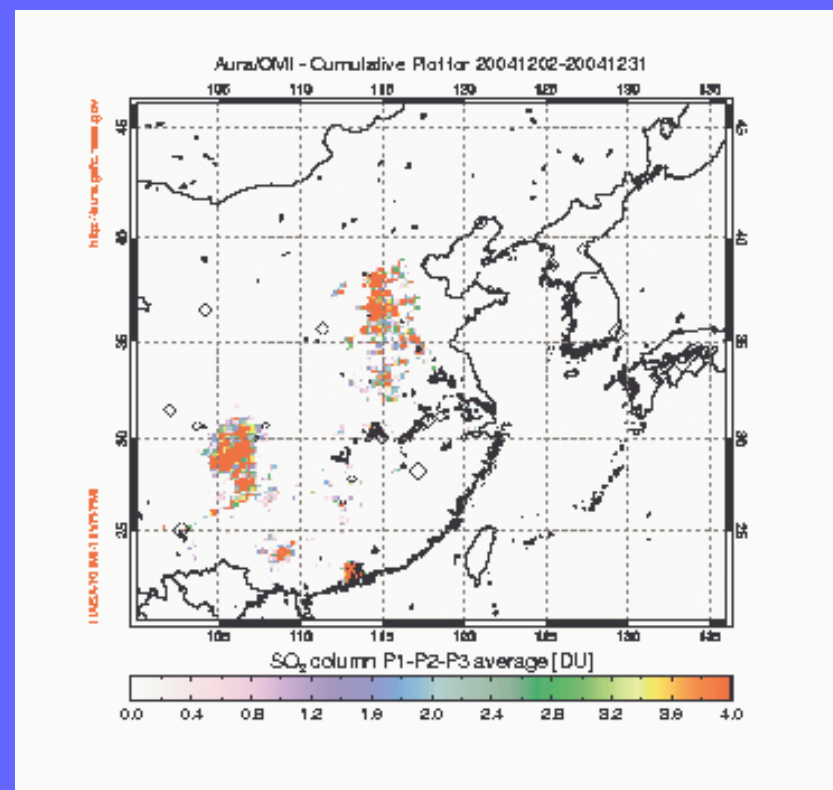
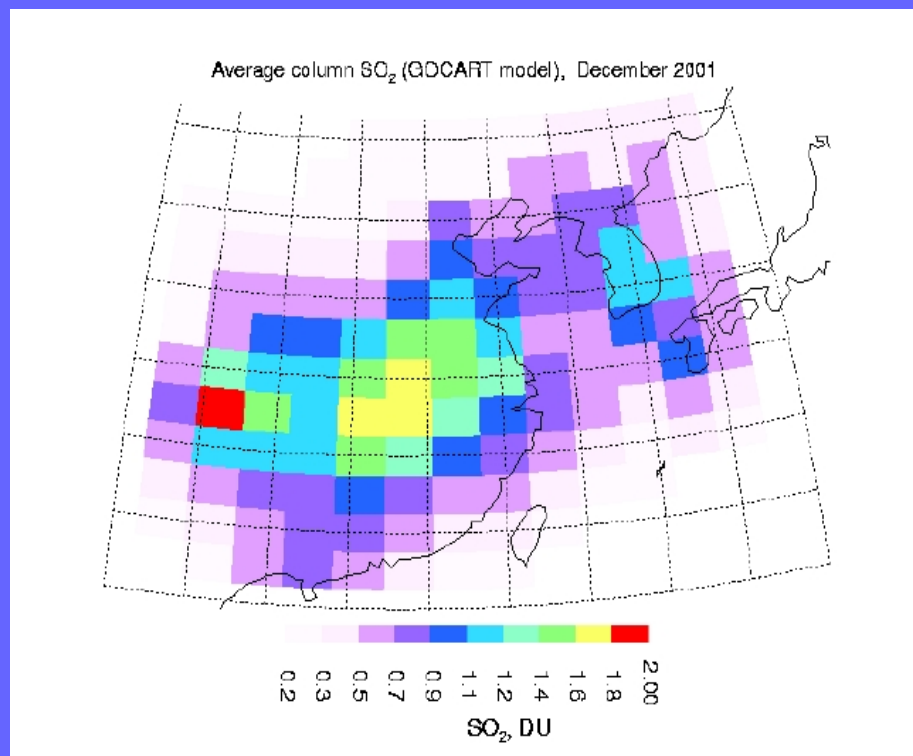
SO₂ below 900mb
(Corrected)



Comparisons with GOCART model

GOCART model
monthly average SO₂
(December 2001)

OMI cumulative
SO₂
(December 2004)

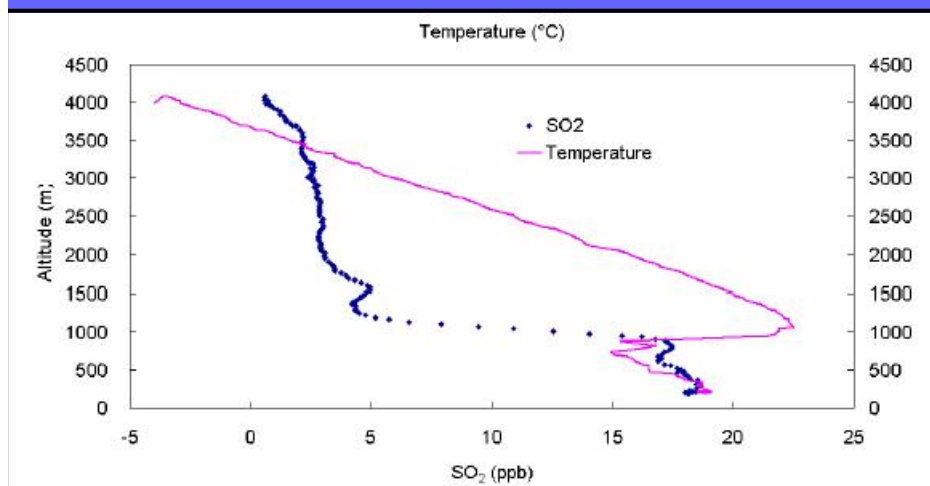


Summary of initial OMI SO₂ validation

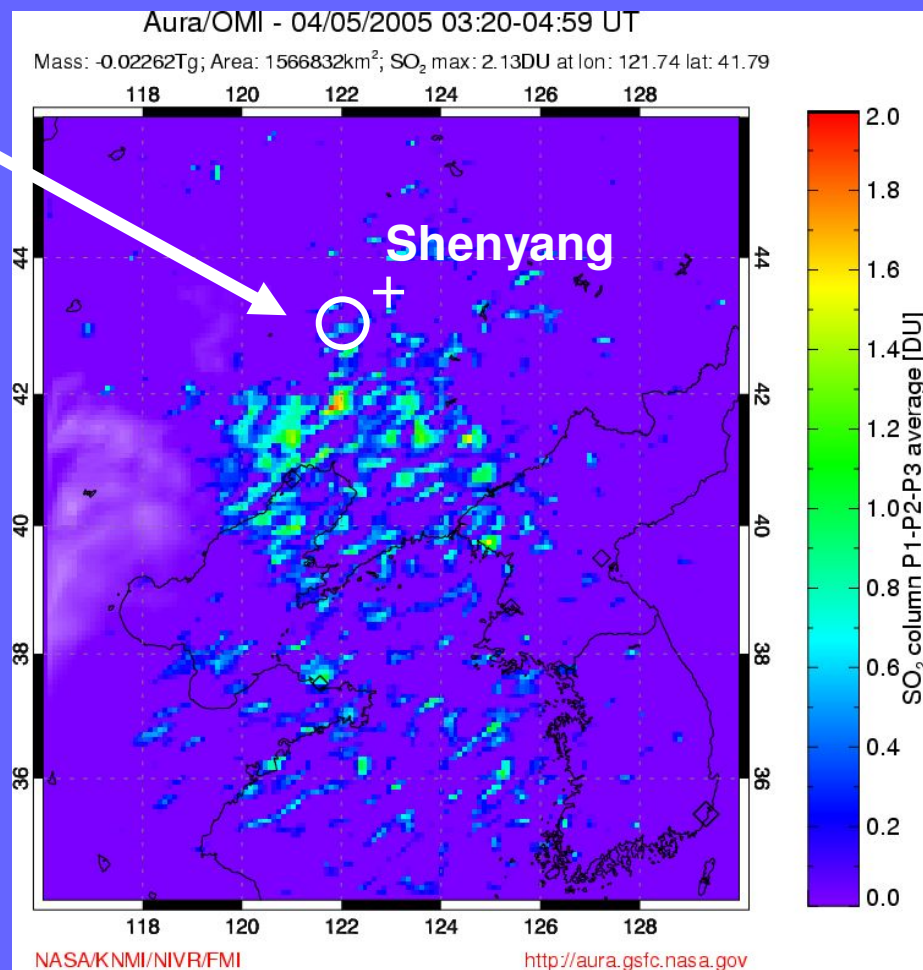
- Anthropogenic SO₂ emissions measured over China, Peru, USA (Ohio Valley), Europe, Central America, Uzbekistan.
(Sources generally in agreement with 1985 GEIA database)
- Algorithm improvements are needed (realistic a-priori vertical SO₂ and temperature profiles, bias, noise) before public release of anthropogenic SO₂ data
- Currently working on validation with UMCP Aircraft in-situ measurements over US mid-Atlantic region in Summer 2005

backup

Comparisons near Shenyang on April 5 2005

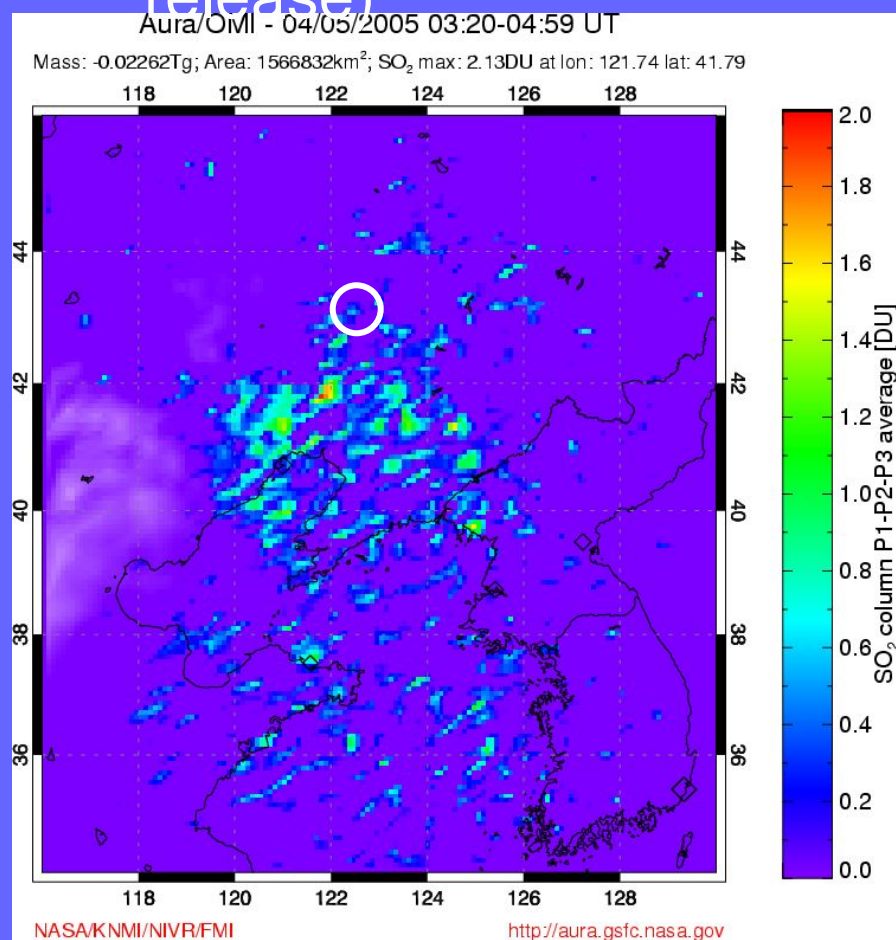


In aircraft profile the column content is ~ 2.2 DU with 0.7 DU in the free troposphere.



A-priori Profile effect on OMI SO₂ retrieval

SO₂ below
700mb
(Provisional
release)



SO₂ below
900mb
(Off-line retrieval)

